





## *Hyphaene guineensis* Schumach. & Thonn. (Arecaceae), a new palm for the flora of Benin

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**Abstract.** We report for the first time the occurrence of *Hyphaene guineensis* Schumach. & Thonn. (Arecaceae) in the flora of Benin at Grand-Popo. We describe this species using stem, leaf, and fruit morphological traits from field observations, specialized keys, historical and modern herbarium vouchers. Demographic and phenological observations are also provided, and a key is proposed for differentiating *H. guineensis* from the other species of *Hyphaene* known from Benin. This work contributes to the knowledge of the geographical distribution, the ecology, and the conservation of *H. guineensis* in tropical Africa.

**Keywords.** Coastal thickets, conservation status, discovery, palm species

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## Introduction

The genus *Hyphaene* Gaertn. (Arecaceae), so-called doum palms, comprises eight species and is distributed in dry regions of continental Africa, Madagascar, the Red Sea region, and the coasts of the Gulf of Eilat, Arabia, and western India (Stauffer et al. 2017). Morphologically, the extraordinary presence of once or twice, much rarely three, times dichotomously branched stems is unique in the palm family (Stauffer et al. 2017); *Hyphaene* is the only genus among the almost 186 genera reported in Arecaceae able to produce this type of branching in a natural way. Within the genus, this character is observed in some species, particularly in *H. thebaica* Mart. and *H. compressa* H.Wendl., and less commonly in *H. coriacea* Gaertn. (Stauffer et al. 2017).

In Benin, only one species of *Hyphaene*, *H. thebaica*

(L.) Mart., has been reported (Akoègninou et al. 2006). Recently, field surveys by the team of the Multipalms Project (<http://www.multipalms.org>) in coastal ecosystems of West Africa recorded *Hyphaene guineensis* Schumach. & Thonn. for the first time from Benin; these records come from Agoué district, municipality of Grand-Popo, where *H. guineensis* was living in thickets degraded by severe agricultural and urban development. Surprisingly, for a long time this species was confused with *H. thebaica*, although the taxonomy of the latter is relatively well understood, and the differences between the species very conspicuous. Moreover, *H. guineensis* has been occasionally misidentified by some collectors as *Borassus aethiopum* Mart., another costapalmate-leaved palm native to tropical Africa (van Valkenburg and Dransfield 2004). Stauffer et al. (2014) characterized *Hyphaene* by the presence of dark

red to black rounded scales on the leaf blade and very indistinct lateral veins, whereas *Borassus* lacks these scales, and the lateral veins are clearly distinct in the leaf blade.

Our new records of *H. guineensis* represent an addition to the flora of Benin and expands the geographic distribution of the species. Unfortunately, this species suffers a long history of habitat fragmentation while it is highly exploited by local people. Its populations encompass only some isolated individuals with rare regenerations and are, thus, largely threatened.

Here, we provided details on the new records of *H. guineensis*, botanical materials examined, important taxonomic characters, a distribution map, data on habitats and ecology, phenology, and key for the Beninese *Hyphaene* species.

## Methods

We carried out field activities in coastal ecosystems of Benin to document all wild palm species and their uses. On 2 September 2021 an unidentified population of *Hyphaene* with fruits was discovered in Abloukoutou village at Agoué district, Grand-Popo, southern Benin. Specimens were collected, allotted collection numbers, pressed, and dried. Another field trip was organized in June 2022 in order to collect supplementary phytogeographical and ecological data.

The taxonomic identification was carried out at the National Herbarium of Benin (acronym: BENIN) using relevant literature (Ouattara 2012; Stauffer et al. 2018, 2021) along with taxonomist confirmations by Fred Stauffer (Geneva Herbarium, G) and Doudjo Noufou Ouattara (Centre Suisse de Recherches Scientifiques, CSRS). Our team has more than 10 years of experience studying West African palms, with several specimens of *H. guineensis* collected in Ghana. The species was confirmed by studying the voucher materials in G (Switzerland) and GC (Department of Botany of the University of Accra, Ghana). We deposited our new specimens in BENIN and G. The geographical coordinates were recorded using a global positioning system receiver, and the distribution map was prepared using ArcGIS v. 9.3.

## Results

### *Hyphaene guineensis* Schumach. & Thonn.

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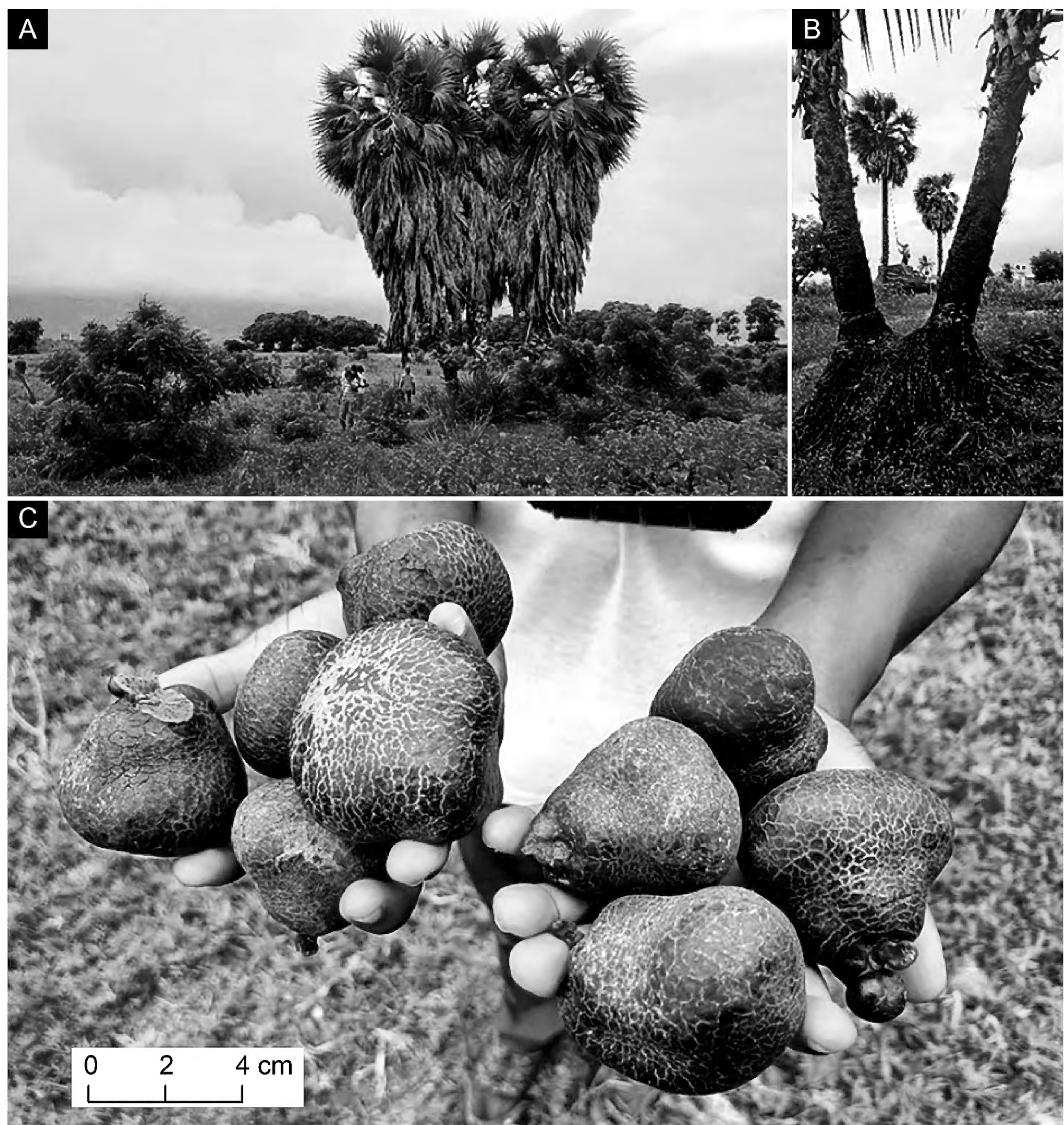
#### Figure 1

New records. BENIN – Grand-Popo • Agoué, Abloukoutou; 06°25.021'N, 001°68.875'E; 7 m alt.; 02.09.2021; F. Stauffer, D. Roguet, D. Ouattara, K. Adeoti, G.H. Dassou, A. Gbenoukpo & J. Makponsè leg.; 2 ♀, 5 unsexed juveniles, BENIN 907 • ibid.; 06°15'18.7"N, 001°41'33.4"E; 25 m alt.; 02.09.2021; same collectors; 4 ♀, 1 ♂, 7 unsexed juveniles, BENIN 915 • ibid.; 06°15'12.9"N, 001°41'19"E; 10 m alt.; 04.11.2021; same collectors; 4 ♂, BENIN 916 • ibid.; 06°15'05.5"N, 001°41'19.4"E; 3 m alt.;

04.11.2021; same collectors; 2 ♀, 2 unsexed juveniles, BENIN 917 • ibid.; 06°15'02.4"N, 001°41'15.4"E; 28 m alt.; 04.11.2021; same collectors; 1 ♂, BENIN 918 • ibid.; 06°15'01.5"N, 001°41'07.0"E; 26 m alt.; 04.11.2021; same collectors; 2 ♂, BENIN 919 • ibid.; 06°15'55.5"N, 001°40'55.2"E; 28 m alt.; 04.11.2021; same collectors; 6 ♂, BENIN 912 • 06°14'51.9"N, 001°40'45.6"E; 7 m alt.; 04.11.2021; same collectors; 2 ♂, BENIN 913.

**Identification.** A dioecious and pleonanthic palm with a solitary and unbranched tall stipe. Stipes grey, erect, solitary or in 2 or 3, originating from the same place; 3–12 m tall, and 30–40 (–50) cm in diameter. Stipes of young individuals often covered with remnant leaf sheaths; aged palms present naked stems and leaf sheaths leave conspicuous rings. Leaves (13–) 30–40 per crown, costapalmate, to 1.8 m long, spirally arranged, green or dark green-bluish; blade covered with small brown dots becoming darker when leaf dries. Leaf sheath to 25 cm long × 10–15 cm wide, brown, with a triangular cleft at base; margins fibrous, armed from the middle with robust, triangular, upward pointing black spines. Petiole (0.5–)1–2 m long × 4–6 cm wide, green-yellowish to light orange, covered with a brown-cream indumentum densely present between petiole spines. Petiole also slightly channelled or flattened adaxially and abaxially convex, then dorso-ventrally compressed in cross-section. Margins armed with robust, triangular, reflexed or upward pointing black spines, 0.8–2 cm long × 0.5–0.8 cm wide at base; spines vary in shape and 1–3 cm apart. Costa 45–70 cm long × to 3 cm wide at the base, and they are strongly recurved, light green, smooth, covered with an light-brown indumentum. Leaf blade to 110 cm long × 80 cm wide, divided at 1/3 of its length into 45–62 (–70) regular, induplicate segments; basal segments 40–85 cm long × 1.3–2.5 (–3) cm wide; middle segments 80–110 (–125) cm long × (2–) 5–7 cm wide; apical segments to 0.7–1.2 m long × to (1–) 4.0–6.0 cm wide. Each segment single-folded and with a 4 cm long, slightly bifid apex; black interfold filaments up to 48 cm long. Indumentum at base of leaf blade and along ribs light brown and smooth, especially on young leaves, becoming caduceous in old leaves. Inflorescences interfoliar, unisexual, pistillate; staminate inflorescences barely similar in architecture, erect; staminate inflorescence to 120 cm long, erect, then slightly pendulous towards end of anthesis; prophyll tubular, 36 cm long towards apex, covered with a brownish indumentum; peduncle 10–30 cm long × 2–3 cm in diameter, elliptical in cross section; peduncular bracts 3, tubular, 45–50 cm long, usually covered with a red-brownish indumentum; peduncle 15–20 cm long × 2–3 cm in diameter, circular in cross section; rachis 50–60 cm long, 1.0–1.5 cm in diameter, circular in cross-section, covered throughout its length by the peduncular bracts; rachillae (3–) 5–12, catkin-like, to 25 cm long and 1.0–1.5 cm in cross-section, sterile part of 20–22 cm, fertile part of 40–50 cm long × 1 cm wide, circular in cross section, inserted in clusters of 3–5 rachillae emerging from same point as main rachis;

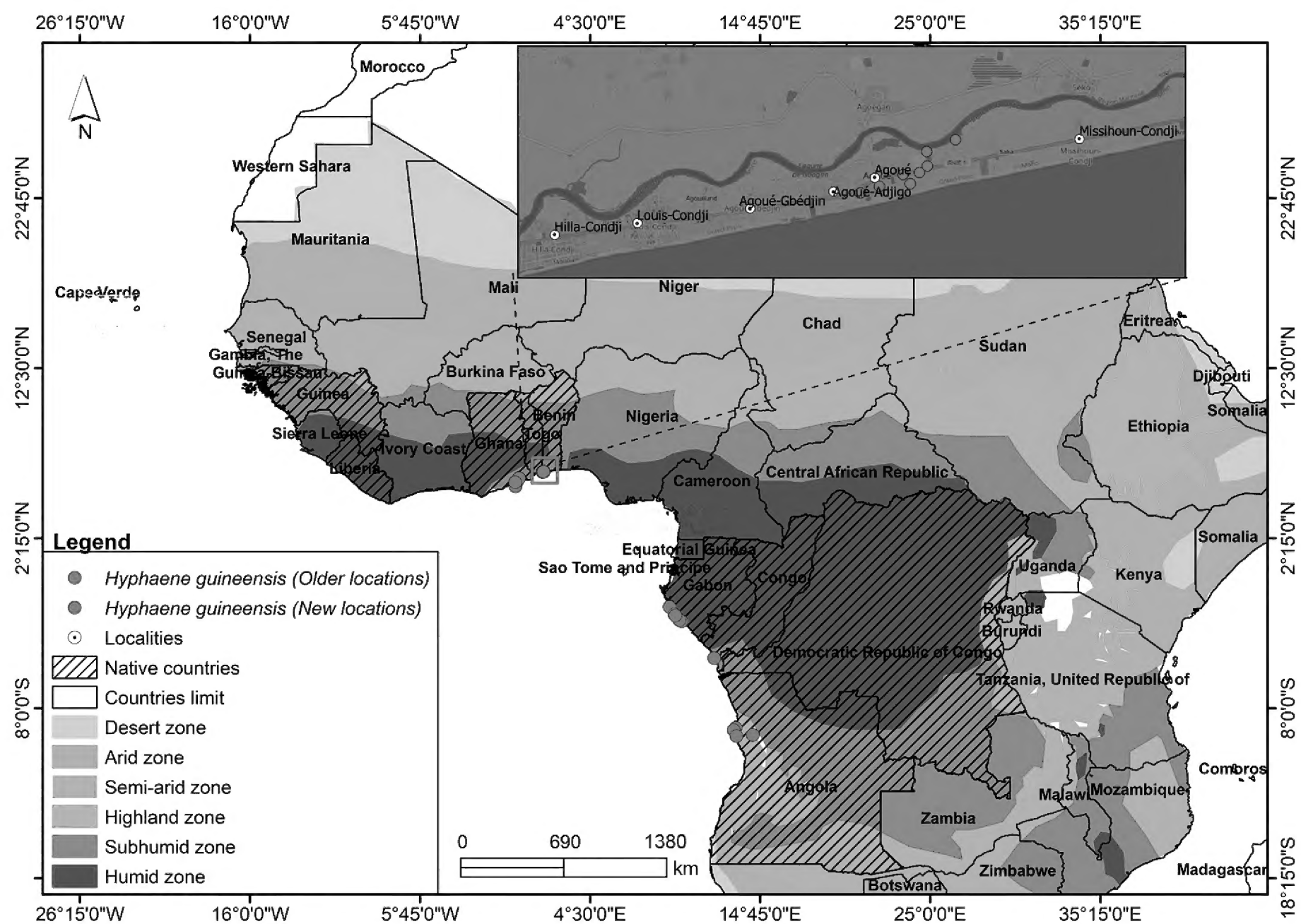




**Figure 1.** *Hyphaene guineensis* Schumach. & Thonn. **A.** Female individual with old, persistent leaves on the stem. **B.** Stem with adventitious roots; note two individuals germinating from a 3-carpellate fruit. **C.** Fruits at ripe stage of development. Photographs: D. Roguet.

rachillae bracts 6 mm long, spirally arranged, striate, connate laterally and partially adnate to rachilla and originating pits, spirally arranged on rachilla, each pit containing 3 flowers arranged in a cincinnus; pistillate inflorescences 5 or 6 growing simultaneously, branching to 2 orders, to 1.1 m long, morphologically similar to the male inflorescence; peduncle 35–50 cm long  $\times$  2–3 cm in diameter, circular to elliptical in cross section; prophyll 35 cm long; peduncular bracts 7, to 42 cm long, tubular, covered with a brown-reddish indumentum; rachis 0.7–1 m long, (1–) 2–4 cm in diameter, elliptical in cross section; at least 1 bract attached to the peduncle, 26 cm long  $\times$  6 cm wide, covered with a wooly indumentum; rachillae 4–6, solitary, rarely in

pairs, alternating in the rachis; sterile part 20–30 cm long, 1 cm wide, adaxially concave, fertile part 16–40 cm long  $\times$  1.1–2.0 cm in diameter, almost circular in cross section, with a 1 cm long sterile and pointed apex; each rachilla subtended by a bract similar to the ones observed in the staminate inflorescence, densely hairy, each pit containing a single flower, larger than male flower. Flowers unisexual, 3-merous; staminate flowers borne in a cincinnus of 3 flowers, 1 flower emerging at a time, arranged in more or less 8 parallel rows, slightly displaying a basipetal anthetic pattern, yellow, scentless, subtended by a minute, membranous bracteole; calyx tubular at the base, lobes 3, acute, elongated; corolla with a stalk-like base, lobes 3, ovate, hooded,



**Figure 2.** Global distribution of *Hyphaene guineensis*. Red circles = previous records, yellow diamond = new records, and blue squares = localities in Benin. Sources: older locations (Stauffer et al. 2021), new locations (our fieldwork), and native locations (POWO 2023).

valvate, striate; stamens 6, inserted at base of corolla, filaments with a swollen base, anthers medifixed, versatile, latrorse to introrse; pistillode 3-lobed, minute. Pistillate flowers borne solitary in each pit, subtended by a membranous bracteole, supported by a short, thick, densely hairy pedicel; sepals 3, distinct, triangular-rounded, imbricate, striate; petals 3, similar to sepals but more flexible; staminodes 6, fused in an epipetalous ring, sagittate, flattened, with undeveloped and empty anthers; gynoecium globose, carpels 3. Fruits 1-seeded, 6.0–7.5 cm long  $\times$  6.0–7.0 (–10.0) cm wide, usually pear-shaped, with 2 conspicuous protrusions near base, borne on a well-differentiated pedicel up to 6–8 mm long, basal stigmatic remains; epicarp olive-green in young fruits, red to brown or dark-brown when ripe, smooth, shiny, waxy, often with the presence of small dots; mesocarp fibrous, to 8 mm thick, sweet; endocarp well developed. Seeds 3.2 cm long  $\times$  2.9 cm wide, endosperm white; eophyll linear, lanceolate, plicate.

**Distribution.** The geographic range of *H. guineensis* constitutes two well-defined areas (Stauffer et al. 2021): one in the Upper Guinea region (Guinea-Bissau, Guinea-Conakry, Ghana and Togo) and another in the Lower Guinea region (Gabon, Republic of the Congo, Central African Republic and Angola). Our new records from Benin expands the geographic range of *H. guineensis*

eastwards in tropical Africa (Fig. 2).

**Habitats and threats.** The species normally occurs in coastal savanna, but we found it in Benin in a degraded thicket on sandy soils in a coastal lowland area. Generally, *H. guineensis* is mostly distributed from sea level to 300 m.

The few individuals spotted in Benin are in a severely disturbed, extremely fragmented habitat. Juveniles plants are in areas where free-ranging cattle do not graze. *Hyphaene guineensis* is a wild fruit tree with multiple uses. It is a food and a medicinal plant of first choice in its geographic range, and also provides quality timber for house construction. The ripe fruits are eaten (notably by children), and its roots are used to treat sexual weakness. Although the Fulani people indicated to us that this species' leaves are a good for weaving mats, bags, and hats, we observed no artefacts made from this palm (leaflets for braiding, fruits, etc.).

**Phenology.** In Ghana, male flowers were found on several individuals in October and mature fruits were collected in the same month. In Benin, mature fruits were identified both in June and September.

**Key to Beninese *Hyphaene*.** The genus *Hyphaene* is now represented by two species in Benin, which can be separated using the following key based on gross-morphological characters.



- Stipe never aerially branched; fruits with two conspicuous protrusions (sterile carpels) at the base ..... *Hyphaene guineensis*
- Stipe always aerially branched; fruits never bearing conspicuous protrusions (sterile carpels) at the base ..... *Hyphaene thebaica*

## Discussion

According to Akoègninou et al. (2006), only one species of *Hyphaene*, *H. thebaica*, occurs in Benin. However, *H. guineensis* has always existed in coastal Benin, but its presence was completely overlooked. Our new records of *H. guineensis* from the country increases the number of *Hyphaene* species to two, out of the eight currently recognized for the genus (Stauffer et al. 2018). The small number of occurrences and the degraded site where we found *H. guineensis* in Benin must raise public awareness for its urgent conservation in the country. We described a similar context in Ghana, and detailed studies have since assessed the species as Critically Endangered in that country (Ouattara et al. 2015). Based on extent of occurrence (EOO) and area of occurrence (AOO) criteria, largely reflecting a hypothetically large geographical range of this species, Cosiaux et al. (2018) proposed that *H. guineensis* is globally Least Concern. However, we predict that the absence of local conservation measures could easily increase its risk of extinction in the near future. Indeed, the few populations spotted in Benin are severely disturbed and only represented in extremely fragmented habitats due to uncontrolled agronomic and urban developments. Thus, further studies are recommended to determine the AOO of *H. guineensis* in Benin and assess its population abundance taking into account two critical life stages (seedlings versus juveniles and vegetative versus reproductive adults). We here suggest conservation measures that might reduce the current threats to the local populations of the species, such as the implementation of environmental education programmes aimed to conserve the palm, protection of juveniles against grazing, and planting of nursery-grown palms, notably on the national Day of the Tree (1 June), in which every citizen is encouraged to plant at least one tree in Benin.

The natural geographic distribution of *H. guineensis* seems to comprise two blocks (Upper and Lower Guinea). Coastal savannas in countries such as Côte d'Ivoire, Nigeria, and Cameroon potentially may also have this species; however, despite of extensive fieldwork in Côte d'Ivoire looking for this palm, its presence in there cannot yet be confirmed (Stauffer et al. 2018). Moreover, the new occurrences are near the border with Togo, which suggests that the species may occur in there; if so, this could suggest that the Benin populations may represent the easternmost limit of a once much larger population extending west to Ghana. To better understand the phytogeography of *H. guineensis*, botanists working in West African countries should join efforts

in the continuation of the national floristic inventories, notably in poorly studied potential sites.

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## Author Contributions

Conceptualization: DR, FS, DNO, KA, GHD; Funding acquisition: DR, FS, DNO. Investigation: DR, FS, DNO, KA, GHD, JM, AS. Data curation: KA, GHD, JM, AS. Formal analysis: GHD, DNO, JM, AS, KA. Methodology: GHD, DNO, KA. Supervision: DR, FS, KA. Validation: DR, FS, KA, GHD, DNO. Writing – original draft: GHD. Writing – review and editing: GHD, DNO.

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